IMPERIAL BUREAU OF PLANT GENETICS: HERBAGE PLANTS

BULLETIN No. 6.

RESEARCH ON FORAGE CROPS IN SOVIET CENTRAL ASIA, WITH SPECIAL REFERENCE TO TURKESTAN LUCERNE.

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ABERYSTWYTH,
WALES.

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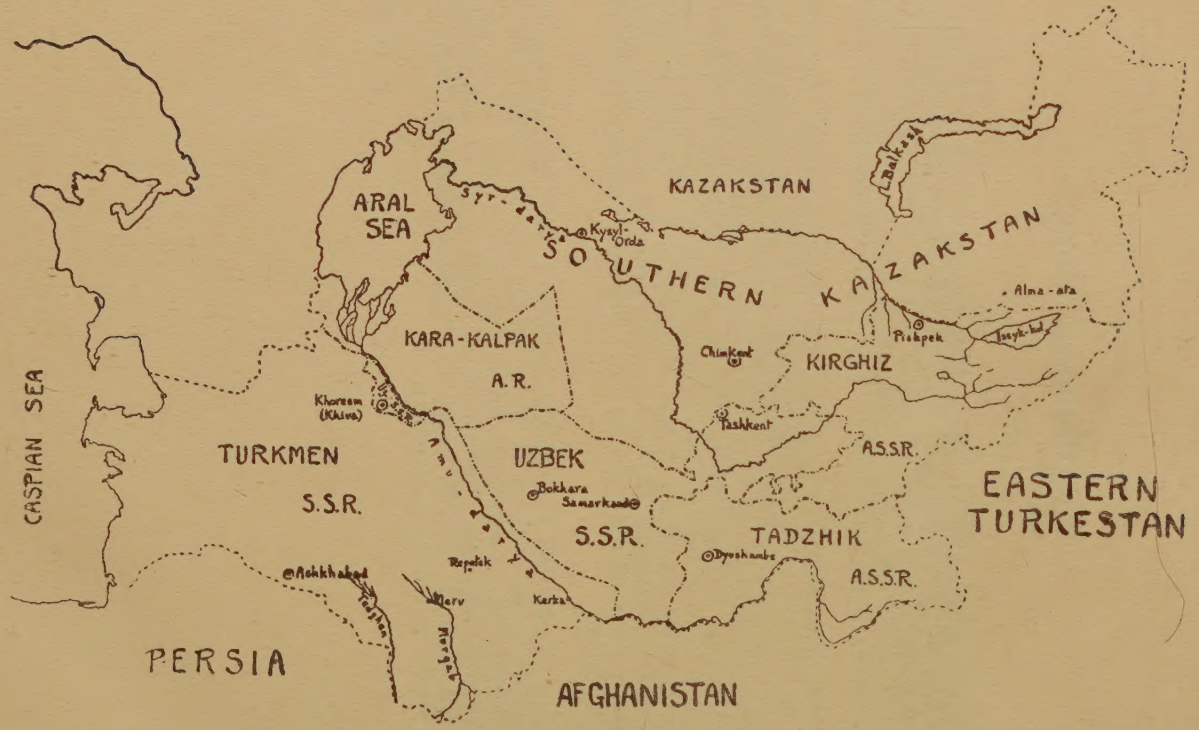
Introductory Note.

An attempt is being made by this Bureau to obtain full and up-to-date information as to research work on forage crops in the various parts of the U.S.S.R., and to present the results of these endeavours in a concise form suitable for the readers of our publications. The degree of success obtained varies somewhat, but it is felt that the information kindly supplied by correspondents in Turkestan (Soviet Central Asia) is such as might be presented in bulletin form without delay.

The data from Soviet Central Asia is of special interest because of the work being carried out with lucerne. As will be noted later, " Turkestan lucerne " occupied at one time a high place in the world lucerne seed supply, but the operation of various factors caused a definite reversal of opinion as to its qualities, with the result that the amount of seed exported fell away very seriously. Recent work in the U.S.S.R. and the United States of America is indicating that, in spite of much divergence of opinion, all is not lost, and that the lucerne export from S.C.A. may revert to a higher figure. It is with this question that the present Bulletin deals primarily. Lucerne breeders and others interested in the crop in the British Empire and in other parts of the world may receive samples for test in the future, and it was thought that this was an opportune moment to present the data in the possession of the Bureau.

For supplying the great bulk of this information either in actual personal communications or in books and pamphlets sent on loan from his library, the Bureau is very deeply indebted to Professor A. I. Belov, and wishes him all the success that his enthusiasm deserves. It also gives the Bureau great pleasure in expressing sincere thanks to Dr. N. Popov, of the Research Institute for Sheep-raising (Alma-ata) and to the U.S.S.R. Society for Cultural Relations with Foreign Countries, for valuable assistance in this and other connections.

R. O. WHYTE.



Administrative subdivisions of Soviet Central Asia.

[1 mm. = 15 klm.]

I.—THE CLIMATIC BELTS AND THE BOTANICAL COMPOSITION OF THE STEPPES OF SOVIET CENTRAL ASIA.

The territory known as Soviet Central Asia (hereafter abbreviated to S.C.A.) is situated to the south of 48 north parallel, and is limited on the other sides by the Caspian Sea, Persia, Afghanistan and Eastern Turkestan. More than two-thirds of S.C.A. consists of a plain not exceeding 500 m. above sea level, which descends in terraces to the Caspian Sea, situated 25 m. below sea level. The remaining third contains the highlands of Tian Shan, Alai and Kopet-dagh, the separate peaks of which approach 7,000 m.

The influence of the relatively small water basins—Caspian and Aral Seas, Issyk Kul and Lake Balkash—which are partly or entirely frozen during winter, is insignificant, affecting only the adjacent coastal districts. Consequently this vast territory has a distinct continental climate, with a marked range in daily and annual temperatures. Being situated in a zone of high barometric pressure, S.C.A. is generally distinguished by low cloudiness, exceptional abundance of light, low rainfall, hot summers and relatively severe winters with small snow cover. The air humidity is also low ; the average annual *absolute* humidity in the plain is 6-7mm. and is approximately proportional to the temperature, reaching its maximum in July ; higher figures are observed either in the vicinity of large water basins (Caspian Sea, etc.) or in zones under extensive irrigation (Kerka). The average annual *relative* humidity varies from 60-70 per cent., frequently falls in deserts below 10 or even 5 per cent. and is also very low in dry barren highlands (Pamir). Its variation is inversely proportional to that of temperature and reaches a maximum during the winter months.

In addition to the influence of latitude, height and relief affect the temperature ; a classification based upon such data (Abolin **1** and **2**) divides S.C.A. into eight distinct temperature belts, arranged as follows :—

TABLE I.

Temperature belts according to Abolin, R. I.	Average Temperature.			Average rainfall in per cent.				Subdivisions adopted in this Bulletin.	Symbol used on map.
	Summer	July	Annual	Autumn winter season.	Summer-Spring Season.				
					Total.	Spring.	Summer		
Extremely hot ..	25–31	25–32	11–17	48	52	39	13	Belt of desert & arid steppe ; rainfall not exceeding 250 mm.	1a.
Hot ..	22–25	22–27	7–13	45	55	37.5	17.5		1b
									1c.
Extremely warm ..	17–22	17–23	3–10	37	63	35	28	Sub-mountainous belt ; rainfall varies between 250-500 m.	2b.
Warm ..	15–17	15–18	1–6	32	68	30	38		2a.
Moderately warm .. subalpine	10–15	10–16	−4—3						
Moderately cold alpine	5–10	5–11	−9—1	36	64	31	33	Mountainous belt, rainfall over 500 mm.	3a.
Cold ..	0–5	0–6	−14—7					Dry barren highlands.	3b.
Extremely cold ..	−15–0	−14–0	−25—14	24	76	30	46		

NOTE.—The relation between F. and C. scales of temperature may be expressed by the formula $\frac{F-32}{9} = \frac{C}{5}$

where F. and C. are actual readings of the same temperature on the Fahrenheit and Centrigrade (Celsius) scales, respectively.)

(a) On the plains, which do not exceed 400-500 metres above sea level, the conditions of typical desert and arid steppe prevail. This belt covers 45 per cent. of the total area of S.C.A., being represented by the Caspian-Aral and central plains, containing the largest sandy zones of S.C.A. (Kara Kum, Kysyl Kum, Muyun Kum), and extending as three separate tongues eastwards between the mountain chains. Rainy winds from the west pass over the hot plain and only in the highlands do they find conditions which lead to condensation of moisture. Consequently throughout the plain complete drought dominates in summer ; only in the cold seasons are the cloudiness and amount of rainfall increased, although the latter does not exceed 250 mm. per annum. The peculiarity of this belt is that the rainfall is almost equally distributed between the autumn-winter and spring-summer seasons ; this fall is, however, not uniform within the seasons, as only six per cent. of the total spring-

Climatic subdivision of Soviet Central Asia.

[1 mm.=20 klm.]
[Indicating also position of deserts and mountain ranges.]
[See Table 1 for explanation of symbols used.]

summer rainfall in the South occurs in summer. The total amount of rainfall, and particularly the summer rainfall, increases to the north and east, as a consequence of the more moderate conditions in those regions. The presence of spring rains causes the vigorous development of an ephemeral vegetation, composed chiefly of Mediterranean genera, among which *Poa bulbosa* is not uncommon, even on the so-called " clay and sand steppe." On more elevated parts of this belt, the ephemeral vegetation is even more rich, being characterised by *Agropyrum trichophorum* in mixtures with various Compositae (*Inula grandis*) and Umbelliferae (*Ferula karatarica, Prangos pabularia*). After vigorous development in early spring, however, this ephemeral vegetation is completely dried up, and by the end of spring, or later in more moderate zones, the steppes present once more the appearance of a " plant cemetery."

In the northern part of this belt (Aral plain) where the amount of spring rainfall is lower, the ephemeral vegetation is somewhat poorer, but the presence of a summer rainfall and a shorter period of summer drought favours the development of psammophytic herbage, with a vegetation period persisting throughout the summer. *Artemisia* steppes (*A. terrae albae*) with *Salsola arbuscula, Anabasis salsa* and other Chenopodiaceae, are widespread. In the north-east part of this belt, where

the total amount of spring and annual rainfall is larger, the rich ephemeral flora of the Chu Valley is again replaced at the end of spring by *Artemisia* steppe, with various Chenopodiaceae, but with in addition *Stipa splendens*, which is absent to the south. On even more moderate steppes is found the association of *Artemisia sublessingiana*, *Festuca* spp., and *Stipa Lessingiana* ; to the north, in Kazakstan and in the sub-mountainous belts of S.C.A., this type of steppe grades into the grass steppe (*Festuca sulcata* and *Stipa Lessingiana*) of the Euro-Asiatic boreal type.

The soil of this belt consists of various types of loess, with 1-2 per cent. of humus. All these types, with the exception of sandy (deserts) and alkaline areas (with a high underground water table) are quite suitable for agriculture, but only under artificial irrigation. Consequently this agriculture is of an oasis character, confined to regions in river valleys and at river mouths. Only 3 per cent. of the total area of this belt of desert and arid steppe is under cultivation, and only 10-15 per cent. of the remainder which is unsuitable for cultivation can be classified as pasture, the main industry being the rearing of Karakul sheep.

(b) At higher elevations, between 400-1000 m. above sea level, the sub-mountainous steppe belt is situated between the deserts and the highlands, and occupies 20-25 per cent. of the total area of S.C.A. The climate is more moderate, with a larger (250-500 mm.) and more uniformly distributed rainfall. The extreme north-eastern portion is rather Siberian in character ; the rainfall approaches the maximum (500 mm.), is still more uniformly distributed, and the summer is cooler and the winter more severe. The belt is covered by dry grass steppes ; north and east of Tashkent the dry grass steppe (boreal type) contains associations of various *Stipa* spp. (*S. capillata*, *S. barbata*, *S. Lessingiana*) and *Festuca* spp., and the *Artemisia* steppe, dominated by *A. sublessingiana*, in drier regions. South of Tashkent the Mediterranean type of steppe, with *Agropyrum* and *Poa*, occurs ; in some cases this vegetation is burnt up during the summer. The boundary between the two associations is very well marked and there is no admixture between them. The soil is richer in humus (2-6 per cent.) than in the previous belt. Soil containing humus is found to a depth of 20-25 cm., below which are carbonates. Soluble salts are completely removed by rain water ; the underground water table occurs at a depth of more than 2-3 metres. As a result of the increased rainfall, cultivation without irrigation (so-called " bogara ") is possible in certain districts, but in spite of this the population is concentrated along river valleys. Owing to the steep slopes on the hills, only 10 per cent. of the total area of this belt is under cultivation. The remainder of the area may be used for pasture, when conditions are favourable ; the agriculture is therefore of a mixed character.

(c) At greater heights the climate gradually changes into a mountainous type, with a more uniform distribution of rainfall (500-1000 mm.), especially upon slopes facing the summer winds ; summer rainfall prevails generally, more especially in the vicinity of Issyk-Kul. The steppes of the previous belt gradually assume the character of sub-alpine grassland, usually of a dry type, with abundant growth of *Avena desertorum*, *Stipa kirghisorum* and *Festuca ovina*. At increased altitudes are found alpine meadows containing *Cobresia schoenoides* and other species. Under drier conditions, the dry alpine steppes are composed of *Stipa mongholica*, *S. purpurea*, *S. Regeliana*, *S. subsessiliflora* and *S. concinna*, which type of steppe is replaced under the influence of a still lower rainfall by *Artemisia* steppe (*A. rhodantha*). The very dry conditions of the Pamir in particular produce a xerophilous type of vegetation, with *Eurotia ceratoides* and *Artemisia Skorniakovii*. The final stage before reaching the eternal snows is characterised by a dry tundra, with patches of vegetation, including among the Gramineae, *Calamagrostis tianschanica* and *Festuca altaica*.

The lower zones of this belt have a rich black soil with a high humus content (8-15 per cent.), present to a depth of 60-100 cm. Rains remove soluble salts. The amount of rainfall would generally be sufficient for " bogara " cultivation, but the steep and stony slopes are limiting factors. The remainder is unsuitable for agriculture, but contains rich mountain pastures, 20-26 per cent. of which are utilised.

The above description, mainly adapted from Abolin's account, is not intended to cover all the peculiarities of climatic and botanical conditions, since this vast territory presents types of infinite variety in this respect. At certain places, at a distance of a few kilometres, all conditions of relief, climate, flora, and soil are sharply changed, but on the other hand larger stretches of territory may be of similar character. Nevertheless, even where conditions are so varied, some regularity may be observed, as is revealed by a more detailed study of the flora. A good example is obtained from the *Artemisia* steppes already described. The most characteristic plant of these steppes is an *Artemisia* from the section Seriphidium, which has in old botanical and geographical works been referred to the species *Artemisia maritima*, described by Linnaeus for the Baltic. A more detailed study shows that this genus may be divided into a number of distinct varieties or even good species, which are limited to certain altitudinal belts. Thus in the *Artemisia*-Chenopodiaceae steppes of the Balkash district, the dominant type is *Artemisia turanica* (*turkestanica*), which is replaced as one approaches the mountains by *A. terrae-albae*, and in the sub-mountainous belt by *A. sublessingiana*. In the *Artemisia* steppes of the inner mountain valleys there is a special cycle of forms. In Central Tian shan, they are composed of *A. tianschanica*, and in West Tian shan of *A. lehmanniana*. In the high plateaux of Tian shan the steppe is composed of a very characteristic species, *A. rhodantha*, and in Pamir of the not less characteristic *A. skorniakovii* (Abolin **1**).

The peculiarities of climate in S.C.A. make possible the development both of arable cultivation and animal husbandry. The latter is carried out either on the mountain or steppe grazing grounds, depending upon the natural fodder supply, or in stables, when the cattle are supplied with hay obtained from the cutting of natural grassland or from crop sowings, in which, as will be shown in later sections, the most important crop is lucerne.

II. LUCERNE IN SOVIET CENTRAL ASIA.

Lucerne has been cultivated in S.C.A. from time immemorial; there is evidence that it was known in ancient Khoresm (Khiva) for a few centuries B.C. and that it was introduced direct from Media, a Persian province, where it was used as fodder for horses. Having cultivated lucerne for centuries as an excellent fodder crop, practical native farmers did not fail to notice the marked increase in the yields of succeeding plants, especially in that of cotton and cereals. This notable property of lucerne in the rotation was not, however, fully realised by the natives until the fundamental knowledge of modern agronomy was introduced in that country; lucerne is now of great value, especially in crop rotation with cotton. According to Professor Yaroshevich (**47**), it may be seen that in belts of cotton mono-cultivation in Golodnaja Steppe (Hunger Steppe), 12.5—33 per cent. of the irrigated lands are assigned to lucerne. Other information (Tzinzerling **43**) referring to the zones of mixed cultivation indicates that in Amu-Darya valley 10.5—13.5 per cent. of the irrigated lands are under lucerne cultivation. Unfortunately, there are not available more up-to-date figures than those presented in the adjoining table, prepared from "The Agricultural Map of U.S.S.R." by Professor Makarov (**28**), which to some extent may show the relative position of lucerne with respect to other important cultures in S.C.A.

TABLE 2.

Province.	Percentage of crops under cultivation													
	Under irrigation.											without irrigation.		
	Wheat.	Barley.	Oats.	Cotton.	Lucerne.	*Andropogon sorghum* Brot.	Maize.	Millet.	*Panicum ialicum* L.	Rice.	Miscellaneous cultures.	Wheat.	Barley.	Miscellaneous cultures.
Transcaspian	65.1	10.0		14 0	5.7	2.5					2.7			
Syr-Darya	35.1	3.3	2.3	10.0	14.6	1.5	1.8	7.2	3.5	15.0	5.7	92.5	4.2	3.3
Samarkand	42.1	11.5		8.7	9.4	4.8	0.1	5.2	0.7	11.5	6.0	87.4	12.3	0.3
Ferghana	22.5	1.3	0.2	29.4	8.0	13.6	9.6	0.8	0.4	9.0	5.2	93.5	5.4	1.1
Semiryechensk..	44.7	5.9	15.4		15.3		0.1	13.0	1.1	0.9	3.6	67.2	7.7	25.1
Bokhara	43.1	10.9		18.1	10.0	5.3		3.0		1.3	8.3	87.4	10.5	2.1
Khiva	21.1	2.8		13.3	14.6	19.9		6.5		7.5	14.3	86.2	13.8	

The progress of the sown acreage under lucerne in S.C.A. may now be discussed. Statistics indicate that lucerne growing increased continuously throughout the pre-war period; thus, according to Kratin (**23**)—

Period 1901-1905 .. 150,614 hectares.
„ 1906-1910 .. 231,630 „ i.e., increased by 35 per cent.
„ 1911-1915 .. 265,580 „ i.e. „ „ 13 per cent.

According to 1912-1914 statistics, however, the total area under lucerne cultivation was 349,257 hectares. The adjoining table shows some particulars of its distribution throughout S.C.A. in modern administrative boundaries.

TABLE 3.

Territory.	Sown acreage under lucerne.	
	1914	1927
	In thousand hectares.	
Uzbek S.R.R.	199.1	110.1
Kirghiz A.S.S.R.	76.3	50.1
Kazak S.S.R. (in S.C.A. boundaries)	41.9	21.9
Turkmen S.S.R.	24.0	20.0
Tadzhik A.S.S.R.	7.9	4.2
S.C.A.	349.2	206.3

The reduction of lucerne cultivation started, therefore, since the Great War and, proceeding rapidly during the years of revolution and civil war, fell in 1919-20 to 104,765 hectares, which did not meet even the local demand for fodder. Such a diminution of the lucerne area since the Great War, and particularly during the period 1917-20, was due to many causes, the most important of which was the loss of the world seed market. The latter was the result not only of purely technical difficulties of export during wars, but also of certain other factors. The main supply of lucerne seed in pre-war times came from France, Italy and S.C.A. The seed from the latter, known by the name of " Turkestan lucerne," exported mainly through the medium of the German market, was priced in the wholesale trade somewhat lower and in the retail sales higher than that from the first two sources. Therefore most of the seed imported into America, which at that time had no internal seed supply, was represented (sometimes up to 95 per cent.) by " Turkestan lucerne " (Stewart **39**). The spread in America of varieties more suitable to the peculiarities of local climatic conditions ought naturally to cause a reduction in imported seed. On the other hand, the commercial success of C.A. lucerne produced unfair speculation ; since 1903-4 the seed of biologically and morphologically different lucernes from various centres of C.A., Persia, Afghanistan and other adjoining countries was exported under the name of Turkestan lucerne, and produced contrary results even when sown under the same conditions (Belov **8**). S.C.A. lucerne was therefore rejected in U.S.A. and included among those seed which must be red coloured (10 per cent.) when imported.

The work at the Turkestan Plant Breeding Station, however, has established that Turkestan lucerne is not homogeneous as was previously considered, but consists of a number of biologically and morphologically different types varying in agricultural value. In addition, it was found by American Experiment Stations that C.A. lucernes are resistant to wilt (*Aplanobacter insidiosum*) and are highly persistent, while recent investigations carried out by Professor N. Kuleshov (**25-27**) and B. Stakevich have shown that some varieties of C.A. lucerne are fairly resistant to dodder. Moreover, the results obtained in trials during the period 1927-30 by L. Bordakov at the Ukrainian Station of the All-Union Institute of Plant Industry (near Kharkov) indicated beyond doubt the high winter resistance of the Khivian type, which in this respect approaches Grimm and Canadian variegated lucernes. Again, the collective varietal testing of lucerne carried out throughout Ukraine during 1926-31 under the general direction of V. M. Rabinovich (**32** and **33**) showed that some C.A. varieties are quite suitable for the stèppe regions of Ukraine, although the investigator remarks that " Turkestan lucerne is not *the* variety for Ukrainian steppes."

This has resulted at present in exceptionally promising conditions for export of lucerne seed from S.C.A. and the increased interest of American and Soviet agronomists during recent years. The representatives of U.S.A. Department of Agriculture, with Dr. H. L. Westover at their head, visited the Turkestan Plant Breeding Station and, accompanied by the members of the Station, together with Professor Kuleshov (**25**), explored the lucerne sowings in various centres of S.C.A. Furthermore from the resolutions passed by the Section of Herbage Plants of the Scientific Technical Council of the Union for Seed Growing on 20-23 May, 1929, it may be seen that lucerne from S.C.A. is projected for many regions of U.S.S.R. Whatever the prospects for future export may be, the internal demand for lucerne is a sufficient stimulus both for more intensive study and cultivation of the crop in S.C.A. Since 1919-20, as soon as peace was established on the border, lucerne growing has recovered rapidly, approaching in 1927 206,301 hectares. Some peculiarities of its distribution at that time are tabulated on p. 10. It is not proposed to discuss in detail lucerne distribution in S.C.A. and it will suffice to mention that in consequence of the peculiarities of physico-geographical conditions (cf. Table 2), lucerne is cultivated under irrigation, with the exception of a few areas situated in sub-mountainous belts.

The recovery of lucerne growing in S.C.A. has continued during recent years, reaching 420,000 hectares in 1931. This progress is due partly to the prospects of an increased seed export, and partly to the following factors. (Ioffe **22**, Gritzenko **19**, Belov **7**.)

1. The development of animal husbandry for beef, milk and wool production on the one hand, and on the other the scarcity in natural pastures, the remoteness of mountain grasslands from agricultural belts, and the reduction of acreage under maize, barley and other forage plants observed during recent years, make lucerne especially important as a forage crop in S.C.A.
2. The inclusion of virgin lands in agriculture in general and particularly in cotton belts necessitates the introduction of lucerne as an accumulator of nitrous and organic substances in soils of S.C.A., which are as a rule very poor in this respect.

3. It was found by a number of experiment institutions that the ability of lucerne in the accumulation of nitrous and organic substances gradually increases as time progresses and reaches its maximum in the 3-4 year ley ; thereafter a decrease is observed as a consequence of soil hardening and the replacement of a depleted lucerne stand by weeds which use the accumulated nitrous and organic substances. In this connection there is a tendency to a more intensive crop rotation, which naturally requires a larger amount of lucerne seed.

The rapid increase in demand for lucerne is, however, not balanced by the development of lucerne cultivation and seed production. Therefore, experiment institutions have devoted special attention to seed production during recent years, both from the biological (pollination, self-fertility, tripping, etc.) and agronomical (method, date, rate of sowings, irrigation, etc.) points of view. Although the problems of seed growing have not yet been thoroughly studied, it is already known that a sunny semi-arid climate and artificial irrigation are among the most important factors in producing high yields. In this respect, S.C.A. has promising conditions and has now been recognised as a centre for lucerne seed growing for U.S.S.R. As regards climatic conditions, the most formidable competitor of S.C.A. is the Ukrainian semi-arid steppe destined to be irrigated by Dneprostroy. It may be expected on *a priori* grounds that the conditions of the Dneprostroy zone are even superior as there is a well-regulated water supply and sufficient sunlight without the excessive air dryness of S.C.A. which on the one hand affects the quality of the seed produced and on the other is one of the factors preventing the spread of S.C.A. lucerne into more humid regions.

S.C.A. lucerne, which has been the object of conflicting opinions as regards its biological and agricultural peculiarities, has not yet been finally systematized ; some writers consider it as a separate lucerne variety under the name of *Medicago sativa turkestanica* (Koburn, Bordakov **12**, etc.), while others include it in or even identify it with the group of Chinese lucerne, known by the name ***Medicago sativa rotundifolia*** Alefeld.

III. ECOTYPES OF TURKESTAN LUCERNE.

A number of important suggestions and facts impelled some Soviet and American scientists to challenge the widespread views as to the defects of S.C.A. lucerne, as had been generally recorded by the Secretary of Agriculture for U.S.A. These suggestions indicated that it was incorrect to consider " Turkestan lucerne " as a homogeneous type, as Turkestan contains distinct regions differing so markedly in their conditions that the lucerne plant, being readily influenced by environment, could be distinguished into different ecotypes according to the habitat in which it was grown (Kuleshov **25-27**). Further experimental study (Belov, **4, 5, 6, 8, 9, 10, 11,** Bordakov **12**) made it possible to establish within " Turkestan lucerne " a number of types with widely different botanical and agricultural properties.

As regards physico-geographical conditions, Central Asia can be divided into four basic bio-lucerne regions :—Khoresm (Khiva), Semiryechensk, Middle Turkestan and South Turkestan. The Khoresm region covers all Khoresm and the lower parts of the Syr-Darya ; the winter is characterised by low temperature (-25° to -30° C.), strong north-east winds and a very thin snow cover. The summer season is rainless, clear and very hot. The Semiryechensk region occupies all North-East S.C.A. and is separated from the remainder of S.C.A. by the Kara-tau, Talas and Alexander mountain chains. Winter temperature is slightly lower, but the snow cover is very deep. The summer is cooler than in Khoresm, the skies are more cloudy, and in certain areas there is a summer rainfall. The Middle Turkestan region occupies the greater part of S.C.A. (Tashkent Ferghana, Samarkand and Bokhara) ; the winter is milder (-8° to -10° C.) than the above regions. The snow cover in the valleys is thin, but thicker than in Khoresm ; in the sub-mountainous belts, it is quite deep and persists for 2-3 months. The summer is very hot and practically cloudless. The Southern region occupies the south of Uzbekistan and Turkmenistan, and is characterised by a complete absence of any snow cover, and a short warm winter with an average temperature of -3° to -5° C. Summer is very hot with dry winds blowing from the desert.

Different ecotypes of lucerne are characteristic of these four regions ; tests of a large number of specimens have shown that the following types can be recognised (Belov **10**).

(i) *Mountain type.* This type has no particular distribution, but may be found in highlands generally. It never occupies large and continuous areas, but is dispersed in outlying villages, on separate fields and plots of land and can be identified only with difficulty from other lucerne crops. Owing, moreover, to the fact that this form is a recessive character, it is rapidly disappearing through cross-pollination into the great mass of other types. It is a late-ripening type with a very noticeable rosette ; the bush is only sightly erect or prostrate, stems are short and few and the foliage is thin. It is more resistant to fungous diseases than the other lucernes, and is very winterhardy. Its productivity is small when compared with other types. The introduction of this type into the northern regions of lucerne cultivation and mountain pastures may, however, be advantageous as the crown is situated below the surface of the soil and cannot be easily damaged under grazing conditions.

(ii) *Khivian (Khoresm) type.* This type is found chiefly in the Khoresm region and at the mouth of the Syr-Darya. It also occurs as an admixture to the indigenous lucernes in other regions of S.C.A., more especially in the cotton belts. This is explained by the fact that the production of lucerne seed is small in the cotton areas and additional quantities have to be imported from Khoresm, where the production of lucerne seed for all S.C.A. has been concentrated.

The Khivian lucerne is an earlier type than Mountain lucerne, but later than other S.C.A. types, with a rosette developed in autumn which is larger and denser than that of the Mountain type. The crown is below the surface of the soil, thus giving high winter-resistance, in which respect Khivian lucerne is second only to Mountain type. The bushes are well branched, especially in the spring and autumn, but become erect in summer. The numerous stems are thick, well-branched with longer internodes, but rough when mature. Leaves are of average size and obovate with hairs of average density, short and compressed. Flowers are of average size, dark violet in colour, on average or short racemes. Pods are dark, rarely light-yellow ; seeds are average in size, kidney-shaped, olive in colour. The hard seed percentage is very small.

It is very susceptible to fungous diseases (*Pseudopeziza medicaginis*, *Peronospora* and others), especially if cultivated in places which are more humid than Khoresm. According to the latest information received in S.C.A. from America, the Khoresm type is more resistant to wilt (*Aplanobacter insidiosum*) than other S.C.A. types ; the disease is not known in S.C.A.

The productivity of the Khivian type is 25-30 per cent. lower than that of the Middle Turkestan type. Having a greater resistance to cold and dry conditions, the Khivian lucerne may be of special interest to countries with severe winter conditions and a low degree of humidity. The spreading of this type throughout large areas has affected its homogeneity with the result that the type as a whole is represented by a mixture of forms.

Lucerne zones of Soviet Central Asia.

[1 mm.=20 klm.]

Broken lines—Mountainous type.

1 —Khivian.
2 —Middle Turkestan.
3 —Semiryechensk.
4 —Turkmen.
5 —Khorasan.

(iii) *Middle Turkestan type.* This type is widespread in all the cotton belts ; to the North-East, it merges with the Semiryechensk sub-type, while in the South-West it merges with the Khorasan type, forming the Turkmen sub-type. The Middle Turkestan type contains a large number of different forms grading into each other. More typical specimens of the type occur in Chinese Turkestan, from which region it was probably introduced into South-East Ferghana.

Growth in spring and after cutting is more rapid than that of Khoresm type, and it persists longer into the autumn. The rosette is not typical, being of " bouquet " type. The plants are semi-erect, internodes of average length, with long, thick, well-branched stems, foliage of average abundance, with large oval leaves. Seed are smaller, more flattened and greener than Khoresm ; hard seeds are almost absent.

It is not so winter-hardy as Khoresm. It is more susceptible to diseases, probably including wilt. Its productivity is higher than other S.C.A. lucernes, rivalling French Provence in yield. It differs from Provence in being later in ripening, taller, with more stems and more abundant foliage, and although the number of cuttings is less, the final yield is similar.

Middle Turkestan lucerne may be suitable for West European conditions. Up to the present, however, the " Turkestan lucerne " which has been under trial at experiment farms and other institutions has been the Khoresm type, as this is the type which has been used for export under the name of " Turkestan lucerne." Reports from many countries stating the low productivity of Turkestan lucerne may be explained by the fact that they tested only the commercial type (Khivian).

(iiia) *Semiryechensk sub-type.* This sub-type occupies an intermediate position between the Middle Turkestan and Khoresm types, and occurs in Kirghiz A.S.S.R. and in adjacent parts of Kazakstan. It is composed of the intermediate forms between the two above-mentioned types and also of forms resulting from crossing with *Medicago falcata.* This type as a result has a very diverse composition, and is distinguished by variegated flowers. The percentage of hard seeds is high ; this percentage increases as the type advances from west to east, parallel with the increase in the presence of wild yellow lucerne in the same direction. Being characterised by a high winter-resistance, large number of stems, abundant foliage and high productivity, this sub-type should be of interest in the countries of north-west Europe, where conditions approach those of its natural habitat.

(iiib) *Turkmen sub-type.* This sub-type occupies an intermediate position between the Khorasan and Middle Turkestan types. Its great height, long internodes, weak foliage and long stems may lead to the conclusion that it has been influenced by the Asia Minor type via Northern Persia. In yield, this sub-type approaches the Middle Turkestan type, owing to its early-ripening capacity.

(iv) *Khorasan type.* This type occurs chiefly in Northern Persia, Northern Afghanistan, and the southern districts of S.C.A. It is characterised by early-ripening, absence of rosette, erect habit, short poorly-branching stems, and by a crown which is level with the surface or a little higher. Winter resistance is probably lower than in other types, but no damage by spring frosts was noted at Tashkent. Disease resistance is lower, the type being liable to attack by *Erysiphe Taurica.* Its productivity is inferior to that of the Middle Turkestan type, because of the smaller number of stems, smaller height and weaker foliage, but is superior to that of Khoresm type, owing to its early-ripening capacity and more frequent cuttings.

In addition to these types established in the Turkestan Plant Breeding Station, " Uzghen lucerne " was discovered in the southern part of Kirghiz A.S.S.R. by T. Gritzenko (**18**) during his tour from 10/9/30—4/11/30 on behalf of the Lucerne Bureau of Plant Breeding Department of N.I.Kh.I. This lucerne is considered by native farmers and agronomists to be more productive than other lucernes of the vicinity. The following peculiarities may be noted :—taller habit, 15-20 cm. higher than other types ; large dark-green leaf ; almost square hollow stems of medium thickness, but not rough ; higher palatability. Collected seed have been sown in the trials and promise well for the future. It has already been recommended for certain zones in the area (**13**).

IV. RESEARCH WORK ON LUCERNE AND OTHER FORAGE CROPS.

In spite of the importance of lucerne in S.C.A., little had been done on the survey and breeding of indigenous lucerne in the pre-war years. In agronomical and agricultural circles, lucerne varieties were recognised, but only from a commercial point of view, without regard to their biological peculiarities. For example, there was a widespread opinion that the Khoresm type was superior to others as regards both quality of commercial seed and hay yield.

" Before the Revolution in S.C.A. there existed the following experiment institutions entirely subjected to the former Department of Agriculture of the Central Office of Agriculture and Agrar-Reforms (Belov 11) :—

1. Zeriavshan Experiment Field on irrigated and non-irrigated lands near (5 klm.) Katta-Kurgan.

2. Ashkhabad Experiment Field on irrigated lands near (3 klm) Ashkhabad.

3. Andijan Experiment Field (lately on the Station) on irrigated lands near (4 klm.) Andijan in Ferghana.

4. Ferghana Cotton Growing (Breeding) Station on irrigated lands near (6 klm.) Namangan (Northern Ferghana) in the place known by the name " Pakhtaly kul " (Cotton Lake).

5. Golodno-Stepnaia Agricultural Experiment Station on irrigated lands near the station " Golodnaia Step " of the Central Asiatic Railway (now Mirzachul).

6. Krassny-Vodopad Experiment Field, 25 klm. north of Tashkent on non-irrigated lands.

7. Burnoe Experiment Field near village Burnoe in the Chimkent Region, north of Tashkent on non-irrigated lands.

8. Turkestan Entomological Station in Tashkent.

" Apart from these, under the direction and finances of the Turkestan Agricultural Society near (12 klm.) Tashkent there was the Tashkent Agricultural Experiment Station. The problems of these experiment institutions included the elaboration of agrotechnical questions as to cultivation of the most important plants in Turkestan (cotton, lucerne, cereals, etc.), breeding of agricultural plants (Ferghana Cotton Growing Station), study of diseases and weeds and their control (Entomological Station), etc.

" In order to relate the programmes, to discuss the problems as to the organization of research work in this Region, etc., there was the Regional Council for research work at the Turkestan Office of Agriculture. During the last years before the war, there were numerous Agricultural and Cotton Growing Conferences, where the reports of experiment institutions were also delivered. In order to show their work the experiment institutions used to publish their annual reports. Also, for wider agricultural circles and progressive farmers the agricultural journal " Turkestanskoe Selskoe Khoziaystvo " was issued in Tashkent, where the research work of experiment institutions was also reported. For the ordinary peasantry, whether Russian or native, a number of popular agricultural journals including " Turkestansky Zemledeletz," both in Russian and Uzbek languages, were published.

" Experiment institutions of Turkestan therefore dealt mainly with husbandry, with special reference to cotton. The breeding work was carried out at the Plant Breeding Department of the Golodno-Stepnaia Agricultural Experiment Station. This Department was conducted by G. S. Zaitzev, our late director. In 1918 he was nominated as the director of the Ferghana Cotton Growing Station, not long opened (1915). In the spring of 1919 the Ferghana Cotton Growing Station was destroyed by ' Basmaches ' (native marauders) and the staff with the remaining seed material removed into Tashkent. The Station settled first on ' Kaplanbek,' the University estate (25 klm. from Tashkent), and afterwards removed into its present situation. G. S. Zaitzev conducted the Station, which was later named the Turkestan Plant Breeding Station, up to the day of his death (January, 1929).

" Before the Revolution, experiment institutions in Turkestan did little work with fodder crops, save some lucerne problems (inoculation, manuring, irrigation, disking and the commencement of varietal testing). Some other fodder crops were occasionally tested, but no distinct results were obtained. Thus, for instance, the Golodno-Stepnaia Agricultural Experiment Station tested in 1906 *Trifolium resupinatum* L., *T. alexandrinum*, *Eragrostis abyssinicum*, fodder beet and other plants, which are not yet introduced into practical agriculture in S.C.A. During the years of the Revolution and Civil War, research work ceased almost entirely and only since 1922-23 has it been gradually restored at the experiment institutions of S.C.A.

" At the time of restoration of old experiment institutions, some new ones were initiated. Thus, for instance, the C.A. Institute of Water Economy with a number of experiment irrigating stations were organised, with the Central Ak-Kavak Experiment Station for Irrigation (15 klm. east of Tashkent) at their head.

" In addition, in the course of the period 1923-30, a number of special institutions, experiment and plant breeding stations were initiated :—

1. C.A. Institute for Sericulture (Tashkent).
2. C.A. Institute for Horticulture and Gardening (Khodzhent).
3. Rice Breeding Experiment Stations (in Samarkand and Tashkent).
4. Station for Oleiferous Cultures.
5. Station for Tobacco Growing (Tashkent), and a number of others less important.

" Among all research institutions existing at present in S.C.A., the most powerful indeed is the Central Asiatic Research Institute for Cotton Growing (abbreviation N.I.Kh.I.). Postal address : N.I.Kh.I. Post Office, Box 101, Tashkent."

N.I.Kh.I.

This Institute was organized in response to the resolution passed by the Central Committee of the U.S.S.R. Communist Party (B) in the autumn of 1929 ; on behalf of the Lenin Academy of Agricultural Science it embraced the experiment institutions of the General Cotton Growing Corporation, the Zaitzev (Turkestan) Plant Breeding Station, the Station for Manuring in Kaunchi, the Entomological Station, and their filial and peripheral organisations. Hence the N.I.Kh.I. is the actual centre of research work with cotton in Central Asia. The central and peripheral organisation of the N.I.Kh.I. consists of the institute, zonal stations, experiment farms and investigation fields. The N.I.Kh.I. also established two branches, one of which is in Transcaucasia ; in this way it covers all the cotton zones of the Soviet Union.

The Central Scientific Research Institute consists of: (a) functional departments, (b) bureaux for study of separate problems, (c) the Central Experiment Field, (d) Institute of Soil Science and Geobotany, (e) central laboratories, (f) industrial departments. These notes are drawn from the Bulletin of the N.I.Kh.I. No. 2, 1930, and represent the initial organization of the N.I.Kh.I. Only those parts of the N.I.Kh.I. which deal with such problems as come within the terms of reference of this Bureau are discussed in any detail.

(a) FUNCTIONAL DEPARTMENTS.

1. *Planning and Inspecting Department* relates the programmes of different departments of the N.I.Kh.I. and carries on general inspection.

2. *Administrative and Financial Department.*

3. *Fundamental Library.*

4. *Editorial Department.*

5. *The group of economical departments* of N.I.Kh.I. embracing (a) the Department of Economy and Organization of Extension Farms, (b) Department of General Economy, and (c) Department of Economy of Cotton Industry.

(b) BUREAUX FOR STUDY OF SEPARATE PROBLEMS.

6. *Bureau for utilisation of foreign experience.*

7. *Mathematical Bureau* unites the work relating to the method of recording and mathematical analysis of material obtained at the experiment establishments.

8. *Bureau for study of vegetative cultivation* is engaged with problems relating to growing of cuttings in various nurseries differently heated (electricity or sun, etc.) and under different conditions of root isolation, mechanization of their planting in ground, and the most advantageous combination of cotton vegetative cultivation with other crops (Cf. p. 21).

9. *Bureau of Energy* deals with problems relating to utilisation of sun, electrical and wind energy for heating of nursery and irrigation of land.

(c) THE CENTRAL EXPERIMENT FIELD has a total acreage of about 450 hectares. Its centralized management is intended for (i) Agro-technical assistance for all trials laid down on the territory of the Central Experiment Field by the departments of the N.I.Kh.I.; (ii) The organization of territory; (iii) The arrangement of work power; (iv) The arrangement of living and mechanical traction, inventory, dwellings, etc.

(d) THE INSTITUTE OF SOIL SCIENCE AND GEOBOTANY deals with the following primary problems:—

i. The composition of soil map.

ii. The survey of vegetation of S.C.A. soils (plant association on virgin lands and weeds on soil under cultivation).

iii. The detailed study of physico-chemical properties of soil and dynamics of organic substances of virgin lands to be introduced into cultivation as well as the study of organic substances, salinity and other problems relating to soil improvement in general.

iv. The preliminary study of soil conditions of trial cotton sowings under "bogara" and soil survey of regions of possible "bogara" cotton growing. The Institute is in the system of the N.I.Kh.I. on a special footing as an independent unit and consequently is able to elaborate problems for non-cotton belts and pasture lands of Central Asia. It is connected with the High Schools of S.C.A.

(e) CENTRAL LABORATORIES :—

1. *Agronomical complex* :—

i. *Agro-chemical laboratory*, intended for localised survey of agro-chemical properties of soil and their variation caused by manurial dressings, irrigation and other effects, in order to investigate methods for improvement of soil fertility. The investigations are carried out by means of agro-chemical and vegetative (pot) methods.

ii. *Agro-physical laboratory* studies the quantitative and qualitative effect on soil caused by different machinery variously combined in soil preparation.

iii. *Cyto-anatomical laboratory* deals with the following main problems :—

(a) The study of chromosome sets (cariotypes).

(b) The study of anatomical structure and its dynamics in diseased and sound plants.

(c) Cytological analysis of material obtained in hybridization and mutation.

(d) Embryological analysis.

(e) Establishment of properties relating to drought, salt resistance, etc.

The laboratory is devoted mainly to cotton, lucerne and *Arachis*.

iv. *Laboratory of Physiology and Microbiology* studies the water-relations of plants and nutritive regions of soil by means of vegetative methods. The transformation of nutritive substances in soil, their progress and appropriation by plants, when various combinations of forms of nutritive substances are supplied, rank among the primary problems and are studied in close collaboration with the Department of Manuring. With the object of establishing the rôle of micro-organisms in soil, a number of trials are carried out by the laboratory which are related to the influence of soil micro-organisms in the process of mineralization of organic substances and the recovery of soil fertility.

2. *Technological Complex* deals only with cotton growing and industry, and consists of :— Spinning laboratory, laboratory for study of cotton filament, chemical and technological laboratory and experiment factory for cotton cleanings.

(f) INDUSTRIAL DEPARTMENTS.

1. *Department of manurial dressings.*

The importance of manurial problems to the relatively poor soils of S.C.A. makes it necessary for the N.I.Kh.I. to devote special attention to the work of the department and its branches. Its problems include the study of the effect of nitrogen, phosphoric acid and potassium supplied in various doses, nitrogen and phosphorus in different relations (2 : 1, 1 : 1, 1 : 2), replacement of organic nitrogen and phosphorus by mineral nitrogen and phosphorus, comparative study of stable manure with mineral mixtures, verification of effect of nitrogen, phosphoric acid and potassium on

various soils according to Mitscherlich's method, the second term of manurial supply, mechanization in supplying and covering of manures, etc. Attention is also devoted to the manurial dressings for lucerne, as a predecessor of cotton, (Herb. Abs. 2. 37. 1932). It is natural therefore that the department works in close collaboration with other departments, and especially with those of Soil Preparation and Mechanization.

The general scheme of work is carried out at the zonal stations, 23 experiment farms and 160 investigation fields. In the latter, however, attention is confined to (i) the study of effect of nitrogen and phosphoric acid manures alone and in mixtures ; (ii) the study of correlation between nitrogen and phosphorus in mixtures (2 : 1, 1 : 1, 1 : 2,) with two times of application and under different rates of irrigation. A large number of manurial trials (about 2000) are also laid down on private farmland.

2. *Department for Mechanization.*

Modern development of cotton growing is based upon the considerable change in the technique of cultivation, which has a tendency to mechanization and application of machinery to all methods adopted in soil preparation and treatment of plants. The elaboration of these problems comes within the terms of reference of this department. The department is also charged with roads, mechanization of transport, electrification, etc.

3. *Department of parasitology and diseases.*

The department includes in its programme the study and control of all plant diseases and pests (Cf. p. 23). In this connection, the department is divided into : phytopathological section, entomological section, laboratory of control and recording section for both expedition and stationary observations.

4. *Department of Husbandry* (*Soil Preparation*).

The problems which come within its terms of reference are carried out by the department in close collaboration with the Institute of Soil Science, Station for Irrigation, and the Department of Mechanization. Special attention is devoted to the establishment of optimal relation between cultures, in order to study problems relating to monocultivation and cotton-lucerne crop rotation.

5. *Department of Irrigation* (*Hydromodule*).

6. *Department of Cotton Technology.*

7. *Department of Plant Breeding.*

This department is centred at the Turkestan Plant Breeding Station, with its filial and peripheral branches. The whole scheme of research work is embraced by the Bureau of Cotton Botany and Genetics, Bureau of Cotton Growing, Bureau of Seed Growing, Bureau for Varietal Testings Bureau of Lucerne and *Arachis*.

Its main problems are concerned with cotton, but work is also carried out with lucerne and other forage crops, *Arachis*, and legumes as green manure. The primary objects are the isolation of highly productive commercial varieties and the elaboration of theoretical and technical problems relating to the biology of the plants (**14**). All work with lucerne is concentrated in the Bureau of Lucerne, under the direction of A. I. Belov. The following further sections from his letter (**11**) indicate the work previously carried out on this crop.

" The work with lucerne was begun at the former Turkestan Plant Breeding Station in 1923. At the commencement a small varietal test of lucerne, clover and sweet clover was laid down. At that time the Turkestan Plant Breeding Station dealt also with a number of other plants, such

as cotton, castor-oil plants, legumes (*Phaseolus aureus*, *Cicer arietinum*, soy beans, etc.) cereal crops, *Sesamum indicum* L. and *Arachis*. Consequently lucerne was of little importance. I worked at that time mainly with cotton, and concentrated together with the late Prof. G. S. Zaitzev on the botanico-morphological study of cotton. In 1924 I touched upon some lucerne problems. In view of the imperfect knowledge of this plant in S.C.A., I was compelled gradually to devote more attention to it, and finally in 1927 I left the work with cotton and devoted myself entirely to lucerne.

" Having noted the considerable differences between indigenous and foreign lucernes, I decided to make a closer acquaintance of the peculiarities of indigenous lucernes. Our main aim was to create selected productive types. But for successful breeding an intimate knowledge of the plant to be bred is essential, and with this object in view I started the study of the lucerne plant in 1925.

" In 1926 the varietal testing of lucerne was initiated first on the territory of the Station. Later the regional set of trials, both on irrigated and non-irrigated lands in Central Asia was organized. The programme of the Net included not only testing of lucerne but also the comparison of lucerne with other fodder crops (sainfoin, clover, sweet clover, etc.). General conclusions reached in varietal testing may be seen in my article published in " Semenovodstvo." In 1925 first selection was done and in 1926 the first breeding nursery was laid down. During the first years (1926-28) practical breeding was not on a large scale. The methods for lucerne breeding were not thoroughly elaborated, and the scarcity of qualified workers and cost and difficulties in obtaining self-pollinated seed prevented fuller development. In 1929-30 the impulse towards more extended practical breeding and progress in genetical work began. Of course, in such a short time little work with lucerne has been done owing to its perennial habit and other difficulties. At the present we have some selected samples obtained as a result of mass and individual selection, twice repeated. This selected material and some original samples of indigenous and foreign lucernes were in 1931 taken into extended multiplication at cotton and seed growing Sovkhoz (with total area of 400 hectares) in different regions of S.C.A. In the beginning of our work with lucerne we first studied the biology and morphology of the plant. In order to obtain more intimate knowledge we were compelled to start with an extended collection of samples of cultivated lucernes and to gradually approach the botanico-morphological study of the world varieties of lucerne. So far as I know, nobody has a larger collection of lucerne than ours and yet some regions are not completely represented.

"The preliminary results obtained in this work were delivered to the U.S.S.R. Conference."

In this paper (Belov 6) results are presented from a study carried on at Tashkent with 1412 samples of world-wide lucerne varieties. These samples were studied with special reference to vegetative characters (shape of bush, characters of raceme, florets, pods and seeds, etc.), biological characters (aftermath, rate of ripening, and resistance to disease, cold and drought), and comparison of productivity. As a result of this study, nine types were recognised, which in addition to the four Central Asia types already enumerated (p. 12) include (5) Asia Minor, (6) Syrian, (7) Arabian, (8) Tripolitanian and (9) European.

Definite regularities may be noted in the geographical distribution of different peculiarities of cultivated lucerne, the chief of these being :

(a) The form of the plant changes from erect to prostrate in the direction from south to north and from lower to higher elevations.

(b) The rate of shooting, either in spring or after cutting, decreases in the same directions.

(c) The length of the vegetative period decreases in the same directions. A more detailed report is in preparation.

To return to the letter from A.I. Belov (11) :—

" At the same time and immediately after the study of biological and morphological properties of lucerne, their combination in various forms and their geographical variation, we were forced to study these properties under different conditions of germination (soil, water, temperature and light, etc.).

" With this object, trials on irrigation, nutritive areas, date of cutting, etc., were laid down, and the study of photo-periodism, lucerne manuring, etc., was commenced.

" These trials produced the material for study of behaviour of properties under various conditions of germination, and the development of methods for experimental breeding.

" For the elaboration of the latter, special trials were laid down to study methods of (a) varietal study, (b) vegetative propagation and (c) artificial pollination."

(a) Belov states (**4** & **5**) that trials on the rate of sowing indicated that thickness of sowing does not alter the relative order of lucernes of different origin as regards their productivity. This finding simplified further varietal testing. Trials with irrigation at various stages of plant development and in various combinations showed such differences in the behaviour of late and early types as had to be taken into account in later varietal testing. The height of the stubble influences in various ways the formation of aftermath of different lucerne varieties.

(b) Preliminary trials with cuttings have indicated that it is possible to plant cuttings directly in soil under local field conditions. Later work on this question has been reported by Golodkovsky (**17**), from the Bureau of Vegetative Propagation. At the present time, the following methods are adopted : (a) planting of cuttings 10 or 20 cm. apart in drills 70 cm. apart, irrigated along the furrows, (b) planting in flat plots, walled by ridges and flooded. Cuttings were planted at distances of 30 × 20 cm. or 20 × 10 cm.

Introduction of sand (16 kg. per sq. metre), when mixed with upper layer of soil, increased the percentage rooting from 31.8 per cent. to 42.7 per cent. Cuttings planted almost immediately gave 95 per cent. rooting, others submerged in water for 3 hours gave 74 per cent., while drying on paper in shadow for 3 and 16 hours gave 77 and 36 per cent. rooting respectively. Cuttings from the middle and tip of plant gave the best results.

The number and length of internodes are of importance. In flooded soil, multi-node cuttings (four-, six- and eight-nodes) gave the best results, but on sandy soil, single node cuttings gave the highest percentage of rooting.

Results of a spring trial indicated correlation between rooting capacity on the one hand and winter resistance and rate of ripening on the other. The result was confirmed by summer trials of a larger number of types ; the following percentages of rooting were obtained : *M. falcata*=90, Central Turkestan=63, Grimm=31, West-European (French)=13, Arabian=9, Tripolitanian=4.

(c) It was found (Belov **4** & **5**) that lucernes of different geographical origin differ from one another in fruit formation under free-pollination. The following percentages were obtained, when West European was taken as 100 :—Africa=91, East-European=70, Afghanistan=49, Central Asia=38, Asia Minor=37. The self-fertility of lucernes varies, but does not coincide with the degree of free-pollination ; percentages were obtained as follows :—Asia Minor=37, Africa=43, European=26.5, Central Asiatic=23-24, Afghanistan=18.6.

As regards the methods of artificial pollination, the trials showed that the florets remain capable of self-fertilisation for a period up to six days from opening. Best results in artificial pollination were obtained at about 10 a.m. and between 3—5 p.m. Various methods of isolation and artificial self-pollination were also tested ; tripping with a match was found to be most suitable in the latter question.

To return to the letter from A. I. Belov (11),

" Here I shall give a few conclusions concerning the study of photo-periodism in lucerne :—

1. Lucerne (*M. sativa*) is a long-day plant.

2. The southern lucernes are less depressed by a shortened day than the northern varieties.

3. The shortening of day delays shooting, flowering and ripening.

4. The southern lucernes from mountain zones (mountainous types) are similar to the northern varieties in their reaction to a shortened day.

" The study of lucerne, as a predecessor of cotton, was begun only two years ago. Here some preliminary examinations of the root system of various lucerne types have been made. The plots with varietal tests of various crops were used to study their effect on cotton yield. According to the results obtained in 1931, lucerne was the best among gramineous and leguminous crops under trial. In this work we had close collaboration with the Central Agro-technical Station, which, using our soil samples, studied the dynamics of N and Ca, the structure of soil and other physico-chemical and chemico-botanical peculiarities of soil under lucerne and other crops.

" We have intended to breed and to establish correct conditions for the cultivation of a lucerne variety which may be used for only one year in the rotation.

" We assume that the most early ripening southern lucernes (e.g. from India, Mesopotamia, Sudan, etc.) which we have studied for a long time, will be accepted for this purpose. With this object in view, we laid down special trials.

" Various other legumes as green manure for cotton were studied in 1930. These crops are designed to be used in Central Asia also as fodder. In this respect work is carried out with racial and varietal study of leguminous crops under autumn (September—October), winter (November—December) and early spring (February—March) sowings, and with selection of winter varieties of legumes.

" The collection of species is so far small (12—15), but the varietal collection is somewhat larger (about 1,000 samples). During the last 2-3 years, the work of selection from other fodder crops intended for conditions of irrigated and non-irrigated lands has been carried out. Here cultivated and indigenous wild plants are tried. The selection is done by means of sowings of collections in duplicate and then through specific testing in larger plots with many replications.

" A uniform scheme of varietal testing is conducted at the zonal stations, experiment farms and Sovkhoz according to our methods. Geographical types of lucerne received from us, two varieties of sainfoin, sweet clover, two varieties of *Agropyrum cristatum* and *A. tenerum* are tested.

" In the spring of 1931 we distributed seed material in the form of individual selections of lucerne from those geographical types, which, in our opinion, were most suitable under the conditions of the station in which they were to be tested. In future, the breeding in country regions will be carried on with samples and material which the stations themselves will produce.

" At the Central Agro-technical Station and zonal stations, the work with lucerne has only recently commenced.

" Therefore, the research work with fodder crops in the N.I.Kh.I. may be (with regard to main points only) summed up as follows :—

" In the Bureau of Lucerne in C.P.—B.S.

1. *The study and collection of world-wide strains of lucerne.*

It consists of the analysis of lucerne variations within a variety with respect to different countries ; the establishment of basic laws of lucerne variation ; the collection of world-wide genera of lucerne, conserving it as living material, and the maximal utilisation of lucerne collection in breeding.

Consequently there are plots and sowings of collection, varietal testing, photo-periodism. " racial competition," etc.

2. *The problem of increase of lucerne yield by means of isolation of specified varieties by using analytic-synthetical method (inbreeding).*

There are plots for breeding.

3. *Problem of introduction into cultivation of best fodder crops and selection from these crops (sweet clover, sainfoin, teff, Eragrostis Abyssinica, etc) to be used on saline and non-irrigated lands and in crop mixtures.*

There are plots with racial and varietal testing.

4. *The problem of maximal increase of seed productivity of lucerne.*

There are trials on the rate, thickness, date and manner of sowing, date of cutting, irrigation, etc.

5. *The problems of green manure with simultaneous (part) utilization for hay.*

There are racial and varietal tests of winter varieties of leguminous crops, trials with date of sowing, selection and collection plots.

6. *The problem of maximal increase in cotton yield after and together with leguminous crops.*

There are sowings of cotton after racial and varietal testing of crops, sowings after and with *Arachis*, sowings done after and together with legumes, etc.

" At the Central Agro-technical Station of N.I.Kh.I."

1. *The problem of increase in cotton yield in crop sowings.*

The study of physical, physico-chemical and biochemical peculiarities and processes of soil under various crops when preceding cotton. Field and laboratory work.

2. *The problem of increase in lucerne yield.*

Elaboration of such agro-technical methods for cultivation of lucerne as may increase its yield. There are trials with manurial dressings, irrigation, etc.

At the Central Entomogical Station.

1. *Study of pests and diseases of lucerne.*
2. *Elaboration of methods of control.*

At the zonal stations.

1. *Isolation of specified lucerne varieties.*
2. *Varietal testing of herbage plants.*
3. *Selection of plants for green manure.*

At the experiment farms.

1. *Varietal testing of fodder crops."*

As regards the filial and peripheral organization of the N.I.Kh.I. (35) the organization of filials and zonal stations is to some extent identical with that of the Institute, i.e. all industrial departments of the centre have corresponding sections or bureaux in filials and zonal stations. The organization of experiment farmlands, which cover smaller areas, may or may not be complete according to the peculiarities of the region. Investigation fields, even smaller units as a rule, contain in their programmes one or two definite items such as varietal testing, manurial trials, etc. The system of the N.I.Kh.I., in addition to the Centre and two filials, includes also 12 zonal stations, 8 of which are in S.C.A. ; 60 experiment farmlands, 44 of which are in S.C.A. Investigation fields are as follows :

1. General varietal testing is carried out at 450 fields.
2. Partial varietal testing is carried out at 2,000 fields.
3. Effect of manuring (in private lands) is studied at 200 fields.
4. Trials with manures are carried out at 100 fields.
5. Trials with the manner of soil preparation are carried out at 30 fields.

There are also in the N.I.Kh.I. élite farms intended for the multiplication and verification of constancy of new varieties. Elite farms cover a total area of 800 hectares, 300 of which are sown down ; in the remaining 500 hectares, cultivation is carried on by means of vegetative propagation.

With regard to the staff and finances, the following scheme was approved for 1930/31 on consultation held on 25-6-1929.

Scientific qualified workers.				Candidates.	Total number of scientists.	Technical workers.	Total number.
1st category.	2nd category.	3rd category.	Total number.				
168	360	234	762	40	802	770	1572

Salary.	Administration expenses.	Operational expenses.	Scientific commissions.	Total.	Scientific equipment.	Buildings.	Total.
4,295,453	310,000	4,504,203	148,349	9.258 005	637,000	2,728,000	3,365,000

Total 12,623,005 roubles, increased later to 14,000,000 roubles.

The scheme of the N.I.Kh.I. above discussed is not conclusive and since the time of its approval some changes have taken place, more particularly on the administrative side. Thus the Departments of Manuring and Soil Preparation were united in the Department of Agrotechnique ; the Institute of Soil Science and Geobotany was included in the N.I.Kh.I. on the footing of Department, although the name was preserved. There were also more important changes ; the Department of " Mass trials " and Propaganda was established in order to associate farmers and Sovkhoz and Kolkhoz with research ; the Institute of Water Economy was included in the N.I.Kh.I., which has consequently changed its title to Scientific Research Institute for Cotton Growing and Irrigation, although the abbreviation has been preserved.

Departments mentioned in the scheme of research described above are now (1932) designated as Central Stations, e.g., Department of Plant Breeding is now the Central Plant Breeding Station, and the Department of Agrotechnique is now the Central Agrotechnical Station.

V. ANIMAL HUSBANDRY AND THE NATURAL FODDER SUPPLY.

After cotton-growing, with the accompanying cultivation of lucerne, the most important branch of agriculture in S.C.A. is animal husbandry. At the XVI. Conference of the All-Union Communist Party (B.) it was recommended that this branch should be rapidly developed, but progress has been delayed by the scarcity of forage supply. The extensive study of forage crops may be expected in the near future. In connection with the character of feeding, two distinct types of animal husbandry may be noted, (a) under grazing conditions (pastures) and (b) under stable conditions. The first type in its development is dependent upon intensive utilisation of natural resources and is frequently accompanied by an arable husbandry of secondary importance, to supplement the natural forage supply. The cattle kept under stable conditions, on the other hand, are dependent for their fodder supply in certain cases upon the by-products of the arable cultivation going on in that district, and in other cases, where animal husbandry is the chief occupation of the zone, upon the cultivation of actual forage crops, the natural fodder area being insufficient for their needs.

S.C.A. can be divided into three agricultural regions, animal husbandry in the desert to the west, and in the steppe to the north, arable cultivation in the centre and animal husbandry on the alpine pastures to the east.

DESERT AND DRY STEPPE PASTURES.

The desert and dry steppe belt occupies the largest part of S.C.A., and has been used for centuries as pasture for sheep, especially of the Karakul type, and for camels. The yield from the Karakul sheep industry (Astrakhan) has decreased since pre-war days to only 6 per cent. of its previous figure. Only 10-15 per cent. of the desert steppe is suitable for grazing conditions. Practical measures which might be adopted to develop animal raising, which is one of the chief means of utilising the sand deserts, are inevitably confronted with a lack of knowledge regarding forage resources, presence of drinking water, the influence of animals on the different types of sand, etc. Further development depends on improvement by means of fixation of sand dunes by plants and the extension of irrigation. These problems are of importance for the scattered oases, where the control of the encroaching sand dunes (" barkhans ") is an urgent matter.

V. A. Paletsky (E. E. Kern **24**) describes the changes in vegetation which occur in the natural fixation of sand dunes ; the eight stages are as follows :—

1. Barren sands which are readily set in motion by winds. Favourable conditions for vegetation are almost absent. Occasional scattered colonies of *Aristida pinnata* and *Ammodendron Conollyi* occur.

2. *Aristida pinnata* and *Ammodendron Conollyi* are much more abundant, and scattered bushes of *Calligonum* spp. may be noted.

3. *Aristida* becomes thin, yielding to *Calligonum*, and *Ammodendron* is weakly developed. *Salsola* spp. may be found rarely.

4. *Salsola* spp. are widespread, replacing *Aristida* and *Calligonum*. Scattered bushes of various races of *Arthrophytum arborescens* make their appearance.

5. The fixation of the sand has commenced. *Arthrophytum* prevails to a marked degree while *Salsola* spp. and *Calligonum* spp. are disappearing, being replaced by *Carex physodes*.

6. The *Arthrophytum* association predominates, and the sand is now fixed.

7. The *Arthrophytum* association becomes thin, and the sand is gradually covered by grasses.

8. The *Arthrophytum* has almost disappeared, and the sand completes the final stage of the cycle of fixation from moving sand dune to grass steppe.

The change from the 1st to the 5th stage occupies 30-40 years and the complete cycle about 80-150 years. The reduction or elongation of the stages is influenced by external circumstances, such as excessive rain or drought, pests, or intensive grazing by animals. When grazing is carried to excess, the 8th stage may revert to the 1st.

With regard to the extension of irrigation, this factor will assume much greater importance owing to the tendency to bring new lands under the cultivation of cotton. The irrigation of the middle regions of the Amu Darya is especially urgent, as all the irrigated arable areas of Turkmen S.S.R. are already under cultivation. This problem has two aspects ; the first concerns the irrigation of comparatively narrow strips along the left bank of the river ; the second concerns the proposal to use the Kilif Uzboi (dry river bed) for the supply of water through south-east Kara Kum to the oases of Murgab and Tedzhen. It may be noted in passing (Girshkan **16**) that this extensive irrigation will necessarily lead to considerable changes in the hydrology of the country in general and more particularly to the drying up of the Aral Sea. E. P. Morgunenkov has suggested that the destruction of the fishery industry in the Aral Sea may be avoided through the deviation of the waters of the Amu Darya into the Sary-kamysh valley.

The preliminary survey of the S.C.A. deserts was begun since the construction of the railways, being carried out by expeditions organised by the Russian Geographical Society. In order to extend the work to such practical questions as the control and utilization of sands, the Repetek Desert Station was organised in 1912. Scarcity of funds did not allow full extension of the work, but observations made upon the desert begun in 1913 were gradually extended up to 1917, when the political conditions caused a shrinkage of the work ; the station was closed in 1918. The territory of the station was involved in subsequent fighting and the instruments and collected material were destroyed. In 1925, on instructions from the S.C.A. Department of Water Economy, the work at the station was renewed and was later subjected to the U.S.S.R. Institute of Plant Industry.

V. A. Doubiansky (**15**), describing the problems of the Station, states— " The methods of rational control of the sands overwhelming cultivated land, khislaks and towns, as well as filling up rivers, channels and irrigation constructions, may be drawn up only with a clear conception of the factors governing the movement of the given sands. Successful control of the danger, either by way of mechanical obstacles or by binding the sands by vegetation, becomes possible only when the direction, method and rate of movement have been established."

" The binding of sands by vegetation must be based upon the study of the natural processes of the spontaneous covering of the sands. This study may be subdivided into the study of the sand vegetation, the biology and morphology of the chief psammophytes, the succession of plant communities and their influence on the occupied sand, causing the commencement of the process of soil formation, which induces greater superficial compactness and salinity of the sand.

" The chief factors in the processes of spontaneous covering, in addition to the movement of the sand are (1) the water regime of the sands, and (2) the chemistry of the sands, which questions are of equal importance for the study of the evolution of the sands.

" The movement of the sand determines its nature, upon which depends its mechanical composition. This, in turn, determines the porosity of the sand, influencing such important properties as permeability to water and water-raising power.

" Favourable moisture conditions preserving in the sands a much greater quantity of available water for plant life than may be observed in other soils with an equal amount of rainfall, as well as the chemical composition of S.C.A. soils, which is quite sufficient for the development of psammophytes, enable these plants to settle on the moving sands and to inaugurate vegetal life." Once begun, these processes determine the further evolution of the sands up to the final stage already noted. " Thus it can be seen that Repetek Station is chiefly concerned with the study of the sands."

The station is primarily interested in Kara Kum, with special reference to the south-east regions in connection with the construction of the Kara Kum canal. The evolution of the cycle of stages in the fixation of sand dunes established by the Station is generally similar to that described in this Bulletin (p. 25). The primary object of the work is not so much the fixation of " barkhans " in general, which process would have its negative results when carried on to excess, as the partial increase of grazing capacity (Doubiansky **15**). In this respect *Astragalus ammodendron confirmans* is of special interest ; its annual herbaceous shoots, up to 0.5 m. long, produce a considerable mass of nutritious fodder very palatable to cattle.

The chemical composition of desert forage crops of S.E. Kara Kum is presented in the following table (**15**) :—

	Hydroscopical water.	Ash.	Fat.	Cellulose.	Nitrogen.	Albuminous substances.	Non-nitrogenous substances.	Time of cutting.
Bromus oxyodon Schr.	8.2	4.75	1.82	17.68	1.29	8.05	67.67	15 May.
Bromus tectorum L.	8.5	4.23	1.68	16.23	1.46	9.12	68.74	15 May.
Poa bulbosa L. var. *vivipara* Roch.	8.1	4.18	3.15	20.47	0.96	6.00	66.20	15 May.
Astragalus filicaulis F. et M. ..	9.3	8.72	2.65	16.35	2.11	13.18	59.10	15 May.
Lucerne (*Medicago sativa*) hay with *Phragmites* ..	8.8	11.52	2.85	15.32	3.25	20.31	50.00	19 May.
Bromus tectorum L.	7.0	4.12	1.64	21.24	0.68	4.28	68.72	9 Sept.
Poa bulbosa L. var. *vivipara* Roche.	7.6	4.12	3.23	17.51	1.1	6.88	68.26	8 Sept.
Aristida pinnata Trin. var. *Karelini* Trin. et Rupr. ..	7.7	6.00	2.36	19.12	1.12	7.00	65.52	11 Sept.

Detailed results of work carried on at Repetek Station have been presented by the All-Union Institute of Plant Industry [Doubiansky (**15**) ; Artzikhovsky (**3**) ; Orlov (**29**) ; Vassiliev (**44**)], and some botanical notes are presented by Seifriz (**38**).

In order to study the fodder question in other dry steppe areas, the Turkmen Fodder Zonal Station was opened in 1931 on irrigated and non-irrigated lands in Gandan, near Ashkhabad.

ALPINE PASTURES.

While " phyto-melioration " and irrigation are the main prerequisites for successful agriculture in the desert belts, transport and the passage of animals between seasonal grazing grounds rank among the most urgent problems of the mountainous belts.

Favourable climatic conditions allow " bogara " cultivation (non-irrigation), but the limitations imposed by relief confine this area to only 3-4 per cent. of the whole. This small area supplies supplementary forage crops for the animals. For similar reasons, the natural grazing grounds and hay meadows occupy only 20-26 per cent. of the total area, which nevertheless possesses great resources for further development of animal husbandry on alpine pastures. Difficulties in transport, relief and the remoteness of inner mountain plateaux are the main conditions governing the fact that this belt should be considered as a zone of animal husbandry, carried on by the intensive utilization of natural fodder resources.

From an administrative and agricultural point of view this belt may be divided into Balkash (Kazakstan), Tian shan (Kirghizistan), and Alai-Pamir (Tadzikistan) regions. The first region is administratively connected with the rest of Kazakstan, and its subalpine pastures are of boreal type, concentrated mainly in Alma-ata (formerly Vernyi) and Dzungar districts. Conditions vary from very dry to comparatively wet. This zone is covered by the Research Institute for Sheep-farming situated in Alma-ata, to which town it has recently been transferred from Uralsk (Western Kazakstan). At present, the Department of Forage Crops is terminating the work commenced before re-organisation (Cf. Herb. Abst. 2. 14 and 18, 1932), and will later be employed with devising a scheme of work in the peripheral zones and with the localised study of problems which for any reason cannot be conducted in the zonal stations or substations. On our request Dr. N. Popov (**36**) has kindly supplied the Bureau with the following notes regarding the main problems of the Station :—

(a) The study of the productivity of natural pastures and swards.

(b) Determination and estimation of varieties and populations of wild and cultivated fodder plants which are intended for intensive multiplication.

(c) Determination and estimation of plants which might increase (1) fattening, (2) milk production, (3) quality and quantity of wool.

(d) Influence of various manners of preparation of fodder (cutting, grinding, steaming, etc.) on its chemical composition and nutritive value.

(e) Silage.

" Field trials are laid down in Sovkhoz, Sheep Trust and Sheep-farming Kolkhoz. Results are published in sporadical bulletins and in the Journal ' Ovtzevodstvo ' (Sheep Industry)."

The animal husbandry of Kirghizistan falls into three zones ; the first is situated along the Talas and the northern foothills of Tian shan (Issyk-kul), in a region characterised by permanent seasonal pastures for sheep. When supported by arable cultivation of crops, especially lucerne, it becomes possible to keep horses and cattle. The second zone is situated in the high inner plateaux, so-called syrts, which are vast boat-shaped valleys surrounded by high and steep inner mountain chains ; one of the sides of such valleys is usually broken by a narrow gorge, through which a mountain torrent flows. " Syrts " occur either between 1000-2500 m., or between 3000-4000 m. The climate of these inner valleys is more dry, rainfall generally being considerably below 500 mm. ; 66 per cent. of this occurs in the spring-summer season, with a summer rainfall prevailing. A dry steppe flora prevails, and in the lower " syrts " may be found a characteristic endemic vegetation of perennial species (*Brachanthemum fruticulosum*, *Salsola Abolinii* Kor., *Anabasis narynensis* Kor., *Reaumuria kaschgarica* etc.). On the upper " syrts," the rich alpine and sub-alpine grassland already described is situated. Supplementary arable cultures include red clover and winter-resistant forms of lucerne. The third zone of the Kirghizistan Region occupies the south slopes of Tian shan and the north slopes of the Alai, and is characterised by a xerophytic vegetation. The whole region of Kirghizistan is covered by the Kirghiz Zonal Fodder Station near Frunze, opened in 1931.

The third (Alai-Pamir) region presents also pasture for seasonal grazing and hay cutting, especially in the vicinity of lakes. The vegetation is, however, generally of a xerophytic character.

RESEARCH ON PASTURES.

From the foregoing paragraphs it may be seen that research on pasture questions is urgently needed, and yet, apart from the work with lucerne in the N.I.Kh.I. and some scattered data from the study or survey of the natural resources of mountains and plains, little has been done up to the present in S.C.A.

" The need for the organisation of a research institute or of such a system as the N.I.Kh.I." states A. I. Belov (11), " which would deal with the whole complex of fodder problems has been for a considerable period in the public mind. Among other problems, the following are urgent :—

1. The problem of organization of fodder supply.

Survey of pastures and fodder lands, distribution of fodder crops, elaboration of scheme of seed rotation in Kolkhoz, etc.

2. The problem of fullest possible utilization of natural fodder resources.

Rational management of pastures, organization of forage supply, etc.

3. The problem of intensive fodder supply.

a. Arable fodder supply (crop sowings, root crops, green manure, etc.).

b. Utilisation of agricultural and waste material (by-products of industry).

4. The problem of extensive fodder supply.

a. The increase of fodder acreage by using lands unsuitable for usual cultivated plants.

b. The increase of productivity of fodder area by admixture of cultivated plants in natural pastures, introducing new fodder crops, etc."

Recently the Collegium of the U.S.S.R. National Commissariat of Agriculture passed a resolution recommending the organisation in S.C.A. of a branch of the All-Union Institute of Herbage Plants (Kachalkino). It is possible that the Bureau of Lucerne will play an important rôle in this matter. This branch would have to direct zonal fodder stations recently opened in the republics of S.C.A.

In the course of 1932, the following stations will be organised :—

1. Repetek Zonal Fodder Station.
2. Tadzhik Zonal Fodder Station in Tissora region for irrigated zones of Pamir-Alai highlands.
3. Uzbek Zonal Fodder Station in Gallya-Aral, for non-irrigated zones of Tian shan.

VI. CONCLUDING NOTE.

As has been shown, research work on agricultural questions, the main pre-requisite for a flourishing national industry, has been almost entirely neglected until recently in S.C.A. The climatic peculiarities are such as do not permit of full utilization of external experience, thus making it necessary for S.C.A. scientists to work out their own problems and their own technique. Difficult political conditions have interrupted work and even destroyed the results obtained in pre-war and pre-Revolution days ; it may therefore be said that agricultural research has been in continuous progress only since 1925, having then started almost *ab initio*. Nevertheless, the valuable results already attained are attracting much interest in other countries.

Actual organisation is still in progress, and there is no permanency of structure. Among other projected institutions, the existing department of the All-Union Institute of Plant Industry near Tashkent will be enlarged to cover all plant-breeding questions of S.C.A. All this work requires large sums of money and many qualified workers, both important limiting factors, but in spite of these and other local difficulties, " the small staff of S.C.A. scientists believes in a better future, works zealously in the interests of the nation and does it not without result." (Belov (11).

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